LAMINOPLASTY WITH LAMINAR STABILIZATION METHOD AND SYSTEM

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BACKGROUND OF THE INVENTION

Cervical stenosis with spinal cord compression and consequent myelopathy is a very common problem encountered by the spine surgeon. The usual cause of multilevel cervical stenosis is spondylosis and/or ossification of the posterior longitudinal ligament. Surgical decompression either through an anterior or posterior approach can be undertaken.

An anterior approach usually involves multilevel corpectomy with fusion and stabilization. The main drawback of this technique is the increased time and complexity of the procedure as well as the risk of pseudoarthrosis and accelerated degeneration at the levels above and below the fusion.

A posterior approach has traditionally involved a simple laminectomy, laminectomy with facet fusion, or more recently laminoplasty. The drawback of a simple laminectomy is the risk of late clinical deterioration form either kyphosis or postlaminectomy scar formation. Laminectomy with facet fusion decreases the risk of kyphosis but it also decreases the range of motion in the spine and increases the risk of accelerated degeneration at the levels above and below the fusion.

Laminoplasty either through open door or double door technique developed more recently provides greater stability and range of motion when compared with laminectomy alone. This technique entails laminoplasty for decompression with laminar fusion with allo- or autograft bone and/or fixation with a plate. The principle behind laminar fusion and fixation is that it maintains the decompression following laminoplasty as well as the

displaced lamina in a fixed position thereby providing stabilization also.

U.S. Pat. No. 6,080,157 to Cathro et al. describes an implant to stabilize the lamina after laminoplasty. A major limitation of this implant and technique is that a single implant extends to all the laminoplasty levels and is followed by posterior autograft fusion thereby disabling the inherent mobility between the cervical spine levels which laminoplasty attempts to preserve.

The present invention is an apparatus for use in laminoplasty to fuse and stabilize the lamina individually in the cervical, thoracic or lumbar spine thereby preserving the range of motion as well as providing stability.

SUMMARY OF THE INVENTION

The present invention relates a laminar fusion and fixation system following laminoplasty. This system with the bone fusion spacer or resorbable fusion graft and plate reduces surgical time and simplifies laminar fusion and fixation after laminoplasty.

The bone fusion spacer consists of a bicortical bone graft with variable length but uniform width and thickness specific for the cervical, thoracic or lumbar spine. The edges are contoured with a notch to allow securement to the lamina on one side and the lateral mass or facet on the other side.

In another embodiment of the bone fusion spacer, the edges have a superior cuff or shoulder that allows securement against the lamina and facet on either sides as well prevent migration of the bone graft into the spinal canal.

The resorbable fusion graft has a design similar to the allograft bone graft but is made of hydroxyapatite or similar absorbable material which is eventually resorbed and/or replaced with autologous bone during the fusion process.

The invention also comprises a plate made of titanium or similar alloy with magnetic resonance imaging compatibility of variable thickness which is contoured at the edges to allow fixation of the laminoplasty and securement of the bone graft. The contoured design of the plate allows screw placement in the lamina or spinous process on one side and the facet on the other side.

In another embodiment the allograft bone or resorbable graft and plate are constructed as a unit with the bone graft attached to the plate in the middle through either screws or an adhesive material.

In another embodiment, the bone graft and plate are designed for laminar fusion and fixation following double door laminoplasty. The bone graft in the middle allows for laminar fusion in the decompressed position with the plate design bent on either end securing the graft to the lamina and facet.

In another embodiment, the plate has appendages that engage the lamina and facet in a fixed position without the use of a bone spacer.

The procedure as would be undertaken with the use of the laminoplasty fixation system is described as follows. An open door laminoplasty entails creating a gutter at the junction of the lamina and medial aspect of the facet on both sides with the use of a drill. On the side of the laminoplasty opening, the drilling is carried through into the canal or the opening completed with a small kerrison rongeur. At the other side, the inner cortex at

the lamina and facet junction is not drilled. The lamina at the open end is elevated and the spinous process pushed away in order to create a greenstick osteotomy and allow for the laminoplasty decompression. Typically, atleast one centimeter of distraction between the lamina and the facet provides for a good spinal decompression. In order to maintain the position of the lamina, the pre-contoured bicortical allograft of appropriate size is positioned between the lamina and the facet. Stabilization at each level is then undertaken with placement of the pre-designed plate with the curved ends to allow one end to secure to the lamina with a screw and the other end to the facet. Alternatively, the bone graft pre-attached to the plate can also be used to provide laminar fusion in the fixed position. In situations where laminoplasty stabilization without the use of a fusion graft is desired, the plate with added appendages to secure the displaced lamina is used.

Another variation on the open door laminoplasty is the expansive laminoplasty most suited for the thoracolumbar spine. In this method, the lamina on either side at the junction of the facets are drilled and opened. A lateral spinal canal recess decompression and/or foraminotomy is undertaken and the lamina replaced with bone graft/plate construct on both sides.

A trap door or double door laminoplasty is created by drilling on each side at the laminar and later mass junction the outer laminar cortex and sparing the inner laminar cortex. The spinous process is resected and a midline gutter is also created which extends through the inner cortex which can be opened with a small kerrison rongeur. The lamina on either side are lifted and opened creating a greenstick osteotomy on each side. In order to maintain the decompressed position of the lamina, a plate alone or a bone graft/plate

construct is placed. The plate can either be fixated with screws to the lamina or the facets. For situations where laminar stabilization without the use of a fusion graft is desired, the plate with appendages in the middle is used.

While the inventions described here are specific, any variations to the described embodiments falls within the scope of the current invention and the protection granted therein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross section of the vertebra

FIG. 2 is a top view of the bone graft

FIG. 3 is a side view of one embodiment of the bone graft

FIG. 4 is a cross section of the vertebra following open door laminoplasty with one embodiment of the bone graft

FIG. 5 is a side view of another embodiment of the bone graft

FIG. 6 is a cross section of the vertebra following open door laminoplasty with another embodiment of the bone graft

FIG. 7 is a top view of one embodiment of the plate

FIG. 8 is a top view of another embodiment of the plate

FIG. 9 is a side view of the plates

FIG. 10 is a top view of the graft and plate construct

FIG. 11 is a side view of one embodiment of the construct

FIG. 12 is a cross section of the vertebra with the graft and plate construct in place

FIG. 13 is a side view of another embodiment of the construct

FIG. 14 is a cross section of the vertebra with the graft and plate construct in place

FIG. 15 is a cross section of the vertebra with expansive laminoplasty

FIG. 16 is a cross section of the vertebra following double door laminoplasty with one embodiment of the bone graft

FIG. 17 is a cross section of the vertebra following double door laminoplasty with another embodiment of the bone graft

FIG. 18 is a top view of one embodiment of the graft and plate construct

FIG. 19 is a side view of the construct

FIG. 20 is a cross section of the vertebra with the graft and plate construct in place

FIG. 21 is a top view of another embodiment of the graft and plate construct

FIG. 22 is a side view of the construct

FIG. 23 is a cross section of the vertebra with the graft and plate construct in place

FIG. 24 is top view of another embodiment of the plate

FIG. 25 is a side view of the plate

FIG. 26 is a cross section of the vertebra with plate in place

FIG. 27 is a side view of another embodiment of the plate

FIG. 28 is a cross section view of the vertebra with the plate in place

FIG. 29 is a top view of another embodiment of the plate

FIG. 30 is a side view of the plate

FIG. 31 is a top view of another embodiment of the plate

FIG. 32 is a side view of the plate

FIG. 33 is a cross section of the vertebra with one embodiment of the plate in place

FIG. 34 is a cross section of the vertebra with another embodiment of the plate in place

DETAILED DESCRIPTION OF THE EMBODIMENTS

A top view of a vertebra is illustrated in FIG. 1 with vertebral body 1, facet 2, junctions of the facet and lamina 3 and 6, lamina 4, spinous process 5, and spinal canal 7.

In one embodiment of the bone fusion device as illustrated in FIGS. 2 and 3, the device has a rectangular configuration with a top surface 9, longitudinal edge 8, side edge 10, and grooved edges 10 and 11 to allow securement to the lamina and facet.

For the open-door technique of laminoplasty, a bicortical opening at the junction of the lamina and facet on one side and a unicortical groove 6 on the other side with a greenstick fracture is created for the laminar displacement as illustrated in FIG. 4. A bone fusion graft 8 is placed between the facet 2 and lamina 4 to maintain the repositioned shape of the laminoplasty that provides decompression of the spinal canal 7.

In another embodiment of the bone fusion device with a longitudinal side 12 and top surface 13 as illustrated in a side view in FIG. 5, the edges at the ends are shouldered with superior cuffs 14 and 16 and edge 15. Following the open-door laminoplasty, as depicted in FIG. 6, the bone fusion device rests between the lamina 4 on one side and facet 2 on the other and the shouldered ends 14 and 16 prevent migration of the graft into the spinal canal 7.

A plate is also used following the laminoplasty to stabilize and fuse the displaced lamina in the decompressed position. The plate has a top surface 20 with several bone screw receiving holes as illustrated in FIG. 7. Screw holes at the ends 17 and 19 secure the plate to the lamina on one side and the facet on the other. Screw hole18 in the center of the plate can be used to secure the bone graft to the plate. In another embodiment of the plate as seen in FIG. 8, there are bone receiving screw holes 21 and 22 throughout the plate 23. As illustrated in FIG. 9, the plates have curved ends to conform to the anatomy of the lamina following the open door laminoplasty technique with a top surface 20 and upward curved end 24 for facet fixation and downward curved end 25 for laminar fixation.

In order to simplify the technique of laminoplasty and provide laminar fusion as well as stabilization, a pre-assembled construct with the plate attached to the bone fusion device is used as illustrated in FIGS. 10, 11, and 13. The plate has a top surface 27 with a curved edge pointing superiorly 30 and inferiorly 31. The bone screw holes at the both ends 28 and 29 allow the plate to be secured to the bone with screws. The bone fusion graft 26 has notches at the ends 32 as seen in FIG. 11, whereas in another embodiment in FIG. 13, the bone fusion graft 33 has shouldered ends 35 with a superior cuff 34. The plate and fusion device construct is placed as seen in FIGS. 12 and 14 following an open-door laminoplasty. The bone fusion devices either 26 or 33 rest between the facet 2 and lamina 4 with the plate 27 secured to the lamina with a screw 37 and to the facet with a screw 36.

For the expansive laminoplasty technique as illustrated in FIG. 15, the plate and

bone fusion construct is used on both sides. On one side, the bone graft 38 rests between the facet 42 and lamina 43 with the plate 39 securing the construct, whereas on the other side, the bone graft 40 rests between the facet 44 and lamina 45 with the plate 41 securing the construct.

The trap door laminoplasty technique as shown in FIGS. 16 and 17 involves removal of the spinous process and creation of unicortical laminoplasty grooves 46 and 47 at the junction of the lamina and facet on both sides. The displaced lamina are then maintained in that position with a bone fusion construct 8 or 12. In one embodiment of the bone graft and plate construct for use in this laminoplasty technique as illustrated in FIGS. 18 and 19, the plate with a top surface 51 has downward angled ends 52 and 53 and is attached to the bone graft 50. The plate has bone screw receiving holes 48 and 49 that allow fixation of the plate to the lamina on both sides. FIG. 20 illustrates the construct in place with the laminar grooves 46 and 47, bone graft 50 and the plate 51 with bone screws 62 and 63 securing the construct to the lamina.

In another embodiment of the bone graft and plate construct for the trap door laminoplasty technique as illustrated in FIGS. 21 and 22, the plate has a top surface 59 with bone screw holes 54 and 58 for fixation to the facets and screw holes 55 and 57 for further fixation to the lamina if needed. The plate also has curved ends 60 and 61 contoured for fixation to the facets. The bone fusion device 56 is attached to the plate in the center. FIG. 23 illustrates the construct in place with the bone graft 56, plate 59 and the plate fixated to the facets through bone screws 64 and 65.

For the technique of open-door laminoplasty, stabilization without laminar fusion

can also be undertaken with the use of the plates as illustrated in FIGS. 24, 25, and 27. The plate has a top surface 66 with bone screw holes at the ends 67 and 68. The ends have a superiorly angled curve at one end 69 and inferiorly angled at the other 70. In one embodiment as seen on the side view in FIG. 25, there is an inferiorly pointing curved hook 72 to engage the lamina at one end and a straight appendage 71 pointing inferiorly at the other end to secure to the facet. In another embodiment of the plate as seen in FIG 27, there is only one appendage pointing inferiorly 72 at the end prior to the downward curvature of the plate. The implanted construct is seen in FIGS. 26 and 28. The plate is secured to the lamina 4 via bone screw 37 and facet 2 via bone screw 36. The hook 72 secures the lamina in the displaced laminoplasty position. As seen in FIG. 26, the additional straight appendage 71 at the facet end allows the plate to rest on the facet 2.

For the trap-door technique of laminoplasty, stabilization without laminar fusion is undertaken with the use of the plates alone. In one embodiment of the plate as illustrated in FIGS. 29 and 30, the plate has a top surface 73 and screw holes at both ends 74 and 75. The appendages 75 and 76 secure the displaced lamina and the curvatures at both ends 74 and 77 allows attachment to the lamina. The implanted plate is shown in FIG. 33 with bone screws 87 and 88 securing it to the lamina on both sides.

In another embodiment as illustrated in FIGS. 31 and 32, the plate is curved at the ends 83 and 86. The plate has a top surface 82 with bone screw holes 79 and 80 for laminar fixation and holes 78 and 81 for facet fixation on both sides. The appendages 84 and 85 secure the displaced lamina. The implanted plate is shown in FIG. 34 with bone screws 87 and 88 securing it to the facets on both sides.

REFERENCES

U.S. Patent Documents

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6241771	June 5, 2001	Gresser